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DEPARTMENT OF AGRICULTURE.

BULLETIN No. 84.

METHODS OF STEER-FEEDING.

THE SECOND YEAR OF

A Co-operative Experiment by the Pennsylvania State Department of Agriculture and the Pennsylvania State College Agricultural Experiment Station, Under the Immediate Supervision of

G. C. WATSON and A. K. RISSER.

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PREFACE.

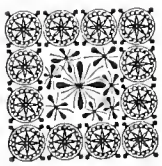
Harrisburg, Pa., September 1, 1901.

The following Bulletin, No. 84, upon "Methods of Steer-Feeding," is the result of a co-operative experiment, undertaken two years ago by the Pennsylvania State College Experiment Station at the instance of the Secretary of Agriculture of Pennsylvania, to test by accurate observation, the comparative effects of feeding cattle by the old method of tying up and turning loose to water each day; and keeping tied in the stall with water constantly before the animals; and the system in which the cattle are loose with free access to water.

The experiment was conducted under the immediate supervision and direction of Prof. George C. Watson, Agriculturist of the Station, assisted by Mr. A. K. Risser.

The experiment is to be continued until the value of the several methods is fully demonstrated.

JOHN HAMILTON,
Secretary of Agriculture.



METHODS OF STEER-FEEDING.

Co-operative Experiment by the Pennsylvania State Department of Agriculture and the Pennsylvania Agricultural Experiment Station.

UNDER THE IMMEDIATE SUPERVISION OF G. C. WATSON AND A. K. RISSER.

Bulletin No. 67, published in August, 1900, gives an account of an experiment which was designed to test various methods of feeding steers. This experiment has been repeated in all essentials and the results described in the following pages. It is recognized that one trial, with a comparatively small number of animals, is not sufficient to determine the many questions involved in such a test. Therefore, the experiment herein described was designed to be largely a repetition of the one made the year previous, in order that the results of the two may be compared and that somewhat more reliable data may be secured for the information of those who are particularly interested in converting the roughage of the farm and commercial stock foods into the more valuable product of prime beef. The narrow margin of profit in feeding steers, which have been reared in other localities, compels the feeders to study closely the strictest economy as to the outlay of labor and money, and to note tendencies even before results are obtained. One object of the trial was to determine as far as possible the comparative cost as well as the efficiency of various methods of feeding.

Plan of the Experiment.

The experiment was devised to test certain practical methods of confining fattening steers as well as to test the usefulness of automatic watering devices for fattening animals as steers are usually confined throughout Pennsylvania. The experiment was designed to determine, if possible:

(1) The effect of different methods of supplying drinking water;

(2) The effect of different methods of confining fattening animals;

(3) The amount of labor required to care for animals under these various conditions.

Experiment No. 2. (Dec. 5, 1900, March 19, 1901.)

In order to make this test as satisfactory as possible under practical conditions, space was set aside in the basement of the college barn in a similar manner to that described in Bulletin No. 67. Three lots of steers were used in this experiment. One lot, Lot No. 1, consisting of ten animals, was placed in a large box stall 20x21½ feet in area, which is exactly the same space that the ten steers would have occupied had they been placed in stalls; that is, the stalls were removed and the space occupied by the stalls enclosed by high board partitions, which made, to all intents and purposes, a large box stall. On account of the lack of space, Lots Nos. 2 and 3 consisted of but six steers each. These were kept in stalls adjoining the box stall. Lot No. 1 (in the box stall) was supplied with water furnished by means of automatic watering basins, in which water was kept before the animals all of the time except when the water was withheld for a short time previous to the weighing periods. Lot No. 2, which consisted of six animals, was supplied with water by means of automatic watering basins similar to Lot No. 1. Lot No. 3 consisted of six animals, and was placed in stalls in a similar manner to Lot No. 2, with the exception that the steers were turned out once each day for an hour or two in a large yard adjoining the basement, where they were permitted to drink in common from a large watering trough. The animals of Lots Nos. 1 and 2 were not removed from the pen and stalls except as it was desired to weigh them on alternate weeks.

The Animals.

The steers used in this experiment were purchased at the stock yards in Pittsburg, November 21, 1900, by Mr. William C. Patterson, the Farm Superintendent, and the writer. In this connection, it should be stated that Mr. Patterson has successfully fattened one or more carloads of steers on the college farm each year for many years, and is recognized as an expert buyer. The steers selected were dehorned grade Shorthorn steers raised in eastern Ohio, and were carefully selected as to size, age and quality, so far as outward appearance would indicate. The steers were sorted into lots soon after they were purchased and were confined in the pens and stalls until the experiment was begun. The steers were sorted with great care in order that the lots might be as uniform as possible and at the same time have nearly the same average weight. These steers were tame and considerably above the

average as to quality and general appearance. They had been given considerable grain and were "well started." In fact, some butchers would have selected a few for slaughter. In the following table (page 10) is given the weights of each steer at the beginning and close of the experiment, as well as at each weighing period on alternate weeks during the period of feeding.

Rations Fed.

Each lot was fed a grain ration consisting of nine parts of corn meal and one part of wheat bran by weight, in such quantities as would be readily consumed. The judgment of an experienced feeder was relied upon to determine the amount that should be given from day to day. An accurate account was kept of the total amount of grain consumed by each lot, but no effort was made to determine the amount of food consumed each day. The grain for each lot was weighed out weekly and placed in a bin. The feeder having access to this bin fed each lot the necessary amount. At the end of the week, that remaining in the bin was weighed and deducted from the amount previously weighed out. In a similar manner an account was kept of the hay and corn stover consumed by each lot of steers. The hay consumed by the three lots was of good and uniform quality, largely timothy with a little clover. The corn stover was well cured and shredded. The hay and corn stover were placed in large sacks and weighed and taken from the sacks and placed in the mangers as required. The unconsumed portions were weighed back and deducted from the total amount offered them, the difference giving the amount consumed. As the refuse was frequently small, it was not weighed back until a considerable amount had accumulated; that is, the unconsumed hay and stover were removed each day and kept until a considerable amount had accumulated, when the whole was weighed and sampled. The following table gives the amount of food consumed weekly by each lot:

Food Consumed.

Date.	Lot I.			Lot II.			Lot III.		
	Hay.	Fodder.	Grain.	Hay.	Fodder.	Grain.	Hay.	Fodder.	Grain.
For Week Ending:									
December 13, 1900,	525	274.5	1,031.0	309.5	112.5	532.5	299.0	89	531.5
December 20, 1900,	509	238.0	1,008.0	302.0	75	539.5	283.0	37	557.5
December 27, 1900,	529	235.0	989.5	293.5	97	638.5	265.5	62	484.5
January 3, 1901,	525	210.0	970.0	288.0	78.5	633.5	289.0	54	600.5
January 10, 1901,	518.5	209.5	1,026.0	293.0	81	666.0	264.5	46	584.5
January 17, 1901,	525	177.0	1,090.0	288.0	62	729.0	255	34	575.5
January 24, 1901,	525	207.0	1,137.0	276.5	63	769.0	265.5	55	660.5
January 31, 1901,	525	199.5	1,219.0	304.5	64	780.5	272	21	753.5
February 7, 1901,	525	190.0	1,253.5	291.5	60.5	820.0	262	40	808.0
February 4, 1901,	525	206.0	1,369.5	301.5	63.5	836.0	292	36.5	779.0
February 21, 1901,	525	182.0	1,330.5	297.5	97	746.0	287	66	675.0
February 28, 1901,	525	214.0	1,449.5	300.0	113.5	783.5	282.5	93	774.0
March 27, 1901,	525	197.5	1,438.0	299.0	103.5	780.5	281	120	685.0
March 14, 1901,	519	216	1,338.5	290.0	119.5	758.0	272	96.5	780.0
March 20, 1901,	440	176	1,265.0	235.0	196.0	637.0	228	86.5	648.0
Total,	7,761.5	3,132.0	17,915.0	4,369.5	1,286.5	10,649.5	4,098.0	936.5	9,896.5
Average per head,	776.15	313.20	1,791.50	728.25	214.4	1,774.7	683.0	156.08	1,649.4

It was observed early in the experiment that Lot No. 3 was not consuming so much corn stover per thousand pounds of live weight of animal as either of the other two lots, yet it did not seem advisable at that time to change the amount given them. Thus, it was noticed that the steers that were turned out to water once a day corresponded quite closely in the consumption of corn stover to a similar lot of the previous experiment. The amount of hay and stover offered each lot and the amount refused are shown below, as well as a similar statement of the previous experiment.

Amounts of Hay and Stover Consumed by each Animal of each Lot.

	Hay offered.	Hay refused.	Hay consumed.	Stover offered.	Stover refused.	Stover consumed.
Experiment No. 1, 1899-1900:						
Lot I,	1,107	11	1,096	503	189	314
	1,091	26	1,065	503	215	288
	1,068	52	1,016	501	321	180
Experiment No. 2, 1900-1901:						
Lot I,	780	4	776	338	75	313
	780	51.5	728.5	393	178	215
	780	97	683	393	236.5	156.5

The animals that were turned out in the yard to water each day did not consume roughage as readily as those that were supplied with water from automatic watering basins.

It will be noticed that Lots Nos. 1 and 2 refused less hay and stover than Lot No. 3; also, that in both experiments Lot No. 1 refused the least hay and stover, that Lot No. 2 refused more and Lot No. 3 refused the most in both instances. In all cases the hay and stover that were not consumed were removed from the mangers and weighed. Practically none was thrown from the mangers and wasted by the steers. It is true that in 1899 and 1900, the three lots were not given quite the same amounts of hay and stover, although the difference in the amounts given was not great, and it should be noticed that the lots that consumed the least were given the least.

Weights and Gains.

In the case of nearly every animal, the increase in weight throughout the experiment showed considerable variation, as seen in the table of weights. This is no doubt due chiefly to the amount of water retained in the system at the time of weighing. In each case, the weight was taken at nine o'clock A. M., and after the water had been withheld for about sixteen hours.

Weights of the Steers at each Weighing.

Number.	Weight at beginning.	Second week.	Fourth week.	Sixth week.	Eighth week.	Tenth week.	Twelfth week.	Fourteenth week.	Final weight.
Lot I.									
63,	959	980.0	1,005.0	1,013.0	1,047.0	1,171.0	1,094.0	1,110.0	1,122.5
64,	1,013	1,052.5	1,080.0	1,127.0	1,173.0	1,211.6	1,200.0	1,232.5	1,242.5
65,	1,005	1,032.0	1,075.0	1,090.0	1,135.0	1,175.0	1,210.0	1,240.0	1,249.0
66,	1,015	1,032.0	967.5	1,098.0	1,117.5	1,160.0	1,191.0	1,202.5	1,216.0
67,	1,023	1,058.0	1,095.0	1,139.0	1,182.5	1,245.0	1,315.0	1,316.0	1,342.0
68,	972	1,035.0	1,044.0	958.0	1,095.0	1,138.0	1,150.0	1,172.5	1,193.0
69,	911	926.0	931.0	960.0	995.0	1,028.0	1,049.0	1,057.5	1,065.0
70,	911	945.0	972.5	980.0	1,000.0	1,010.0	1,041.0	1,070.0	1,069.5
71,	884	941.0	960.0	996.0	1,055.5	1,052.0	1,091.0	1,132.0	1,128.0
72,	788	815.0	840.0	869.0	891.0	919.0	950.0	980.0	990.0
Average,	948.0	982.0	997.0	1,023.0	1,069.0	1,111.0	1,129.0	1,151.5	1,162.0
Lot II.									
51,	882	912.5	951.5	980.0	1,025.0	1,059.5	1,083.5	1,100.0	1,127.0
52,	1,015	1,050.0	1,069 5	1,095.5	1,140.0	1,172.5	1,177.5	1,179.5	1,182.5
53,	963	1,007.5	1,019.5	1,055.5	1,087.5	1,116.5	1,140.0	1,172.5	1,184.5
54,	862	892.5	937.5	992.5	1,008.5	1,062.5	1,095.0	1,120.0	1,128.0
55,	976	1,007.5	940.5	1,062.0	1,102.5	1,155.0	1,187.5	1,217.5	1,238 0
56,	992	1,017.5	940.0	1,095.5	1,134.5	1,152.5	1,167.5	1,190.0	1,191.5
Average,	948.5	981.0	976.5	1,047.0	1,083.0	1,120.0	1,143.5	1,163.0	1,175.0
Lot III.									
57,	1,065.5	1,087.5	1,105.0	1,135.0	1,167.5	1,198.0	1,213.5	1,250.0	1,257.5
58,	1,064.5	1,117.5	1,150.0	1,155.0	1,180.0	1,213.0	1,218.5	1,237.5	1,244.0
59,	872.0	918.0	957.5	1,012.0	1,037.5	1,045.5	1,097.0	1,105.5	1,110.5
60,	888.5	917.5	965.5	975.0	1,010.0	1,037.5	1,067.5	1,092.5	1,096.5
61,	889.0	927.5	918.5	957.5	1,026.5	1,052.5	1,085.0	1,110.0	1,087.0
62,	923.5	947.5	975.0	962.5	1,030.0	1,053.5	1,078.5	1,085.0	1,087 5
Average,	950.5	986.0	1,012.0	1,033.0	1,075.0	1,100.0	1,126.5	1,146.5	1,147.0

The weights at the beginning and end of the experiment were obtained by weighing each individual animal on three consecutive days and taking the average of these weights. It is well known that a single weight may be quite misleading as regards the true weight of the animal. As shown in the table of weights, some individuals at some weighings apparently lost weight. This is undoubtedly due to the variation of the water in the system of the animal at the time of weighing and not to any unthrifty condition at that time, as some of these animals have made most excellent gains throughout the whole period of feeding, which would not have been expected had they actually lost in weight during two or four weeks of the feeding, as indicated by the table of weights. Animal No. 68 of Lot No. 1, at the third and fourth weighing, indicated a loss of 77 pounds for four weeks, while this animal gained throughout the whole period an average of 2.13 pounds per day. Without doubt, the weights were misleading and the animal did not show an unprofitable feeding condition. The following table gives the gain of each individual of each lot:

Steer No.	First weighing.	Last weighing.	Total gain, pounds.	Gain, per cent.	Gain per day, pounds.
63,	959	1,122.5	163.5	17.05	1.57
64,	1,013	1,242.5	229.5	22.66	2.21
65,	1,005	1,249	244	24.28	2.35
66,	1,015	1,216	201	19.91	1.93
67,	1,023	1,342	319	31.18	3.07
68,	972	1,193	221	22.74	2.13
69,	911	1,065	154	16.90	1.48
70,	911	1,069.5	158.5	17.40	1.52
71,	884	1,128	244	27.60	2.35
72,	788	990	202	25.63	1.94
Total,	9,481	11,617.5	2,136.5	.....	20.54
Average,	.....	.....	.....	.....	2.05
51,	882	1,127	245	27.78	2.36
52,	1,015	1,182.5	167.5	16.50	1.62
53,	963	1,184.5	221.5	23.00	2.13
54,	862	1,128	266	30.86	2.56
55,	976	1,238	262	26.86	2.52
56,	992	1,191.5	199.5	20.12	1.92
Total,	5,690	7,051.5	1,361.5	.....	13.09
Average,	.....	.....	.....	.....	2.18
57,	1,065.5	1,257.5	192	18.02	1.85
58,	1,064.5	1,244	179.5	16.81	1.72
59,	872	1,110.5	238.5	27.35	2.29
60,	888.5	1,096.5	208	23.41	2.00
61,	889	1,087	198	22.28	1.90
62,	923.5	1,087.5	164	17.76	1.57
Total,	5,703	6,883	1,180	.....	11.34
Average,	.....	.....	.....	.....	1.89

From the above table it will readily be seen that Lot No. 2 made the greatest average gain per day; also, that Lot No. 1 occupies a medium position between Lots Nos. 2 and 3. There it not difference enough in the gains of the three lots to warrant the claim of marked superiority of one method over another, as the three lots gave about as uniform results as would be expected from three lots kept under uniform conditions. The objection to feeding a number of steers in a yard or pen has been raised, that there is likely to be both underlings and those that make unusually good gains. It is true that steer No. 67, of Lot No. 1, made considerably greater gain than any in Lots Nos. 2 or 3, and also that one steer, No. 69, made the least gain of any of the three lots, although No. 62, of Lot No. 3, which was confined in a stall, did not greatly exceed the small gain of steer No. 69. While the gains of the steers of Lot No. 1 occupy both extremes, yet they are sufficiently pronounced to warrant any definite conclusions being drawn from these results. The following table gives the amount of food consumed by each lot per pound of gain of live weight:

Food Consumed per Pound of Gain in Live Weight.

	Hay.	Stover.	Grain.
Lot I,	3.62	1.46	8.39
Lot II,	3.21	.94	7.82
Lot III,	3.47	.79	8.39

Amount of Food Consumed.

	Hay.		Stover.		Grain.	
	Total.	Per 1,000 pounds, live weight.	Total.	Per 1,000 pounds, live weight.	Total.	Per 1,000 pounds, live weight.
Lot I,	7,761.5	735.7	3,132.0	296	17,915	1,698
Lot II,	4,369.5	684.5	1,286.5	202	10,649.5	1,671
Lot III,	4,098.0	651.2	936.5	148.8	9,896.5	1,572

From the above it is seen that Lot. No. 2 made a pound of gain in live weight with the least amount of food. This lot also made the greatest total gain per day throughout the whole time of feeding. While Lot No. 1 made a somewhat greater gain than Lot No. 3, it evidently was at a somewhat greater expense of food, as Lot No.

3 required a trifle less food to produce a pound of gain than Lot No. 1. It is also shown that Lot No. 3 consumed less food per thousand pounds of live weight than either of the other two lots.

The differences in the results of these two methods of feeding, as shown by these trials, are not sufficient to warrant definite conclusions.

Experiment No. 3.

On April 1, 1901, six steers were placed on experiment similar to the one previously described. The main object of this experiment, however, was to determine whether there was a great difference in the retention and preservation of the manure made from the three lots. The steers were weighed at the beginning and end of the experiment, as described in experiment No. 1, and the food was weighed and fed as described in that experiment. Each lot consisted of two steers. The steers of Lot No. 1 were loose in a box stall and supplied with water by means of an automatic watering basin. The steers of Lot No. 2 were confined in stalls, but supplied with water by automatic watering basins, and Lot No. 3 was watered as were the animals of Lot No. 3 of experiment No. 2. The following table gives the weights of the steers at the beginning and end of the experiment, gain per cent. and gain per day in pounds:

	First weighing.	Last weighing.	Total gain, pounds.	Gain, per cent.	Gain per day, pounds.
Lot I.					
Steer No. 1,	912	1,081	169	18.53	2.96
Steer No. 2,	876	1,016	140	15.98	2.46
Average,	894	1,048.5	154.5	.....	2.71
Lot II.					
Steer No. 3,	926	1,075	149	16.09	2.61
Steer No. 4,	862	1,046	184	21.35	3.23
Average,	894	1,060.5	166.5	.....	2.92
Lot III.					
Steer No. 5,	976	1,131	155	15.88	3.04
Steer No. 6,	784	905	121	15.43	2.37
Average,	880	1,018	138	.....	2.70

It will be observed that Lot No. 2 made a slightly greater gain than either of the other lots. Lots Nos. 1 and 3 were practically the same. The following table gives the food consumed for each lot. It should be noted that the coarse fodder fed these three lots consisted entirely of hay. While the gain of these steers in live weight corresponds quite closely to that of experiment No. 1, yet it is shown below that Lot No. 3 consumed considerably less food per pound of gain of live weight than either of the other two lots.

Food Consumed.

Date. For Week Ending:	Lot I.		Lot II.		Lot III.	
	Hay.	Grain.	Hay.	Grain.	Hay.	Grain.
April 9,	168	189	141	200	91	166
April 16,	164	228	144	206	87.5	148
April 23,	164	237	138	191	82	141
April 30,	167	200	164.5	218	128.5	169
May 7,	177.5	235	155.5	223.5	124.5	216
May 14,	176	234.5	160.5	224	129	234.5
May 21,	163	234	175	220	155	231
May 29,	192	268	173.5	264	†33	†60
Total,	1,371.5	1,825.5	1,252.0	1,746.5	840.5	1,365.5

† For two days only, Lot III was sold May 23.

Food Consumed per Pound of Gain in Live Weight.

	Hay.	Grain.
Lot I,	4.44	5.91
Lot II,	3.76	5.24
Lot III,	3.45	4.95

Labor Required.

The labor of attendance is often a deciding factor in the selection of stock for fattening, and it also determines the manner in which the stock should be fed. The cost of the manual labor required to take proper care of the stock in question sometimes determines the profit. Systems of feeding that require the least labor are to be preferred, provided, they are equal as to the amount of food required and the gain secured. The following table shows the amount of labor required for attendance for each lot during the entire feeding experiment of 104 days:

Time of One Man Required for Attendance.

	Number of animals.	Actual number of hours.	Hours.	Percentage of Lot 3.
Lot I,	10	79.6	79.6	51
Lot II,	6	88.8	*148.0	*95
Lot III,	6	93.3	*155.5	.....

* Calculated to ten animals, the number in Lot I.

As shown above, it required 79.6 hours of actual labor of one man to attend to ten animals of Lot No. 1, and 93.3 hours of labor to care for six animals of Lot No. 3 that were kept in stalls and turned out to water once each day. If this proportion is used to determine the amount of labor required to care for ten animals in stalls, it will be seen, as shown in the above table, that steers in pens furnished with automatic watering basins required about one-half as much time of the attendant to properly care for them as was required to attend to the same number of animals kept in stalls and turned out in a yard to water. The stalls were cleaned out each day and the box stall was cleaned out twice during the experiment. The following table is taken from Bulletin No. 67, which gives the difference in time required to care for the three lots of animals which were kept under similar conditions as those described in the preceding pages:

Time of One Man Required for Attendance.

	Hours.	Percentage of Lot III.
Lot I,	93.66	76.0
Lot II,	113.33	92.0
Lot III,	123.25	.....

In this experiment each lot consisted of five animals, which undoubtedly made the lots too small to note the greatest difference in the time of attendance.

Bedding Required.

It has been maintained that there is a saving in bedding when the animals are kept in large pens or yards. The question of saving bedding is oftentimes of considerable importance. In some localities, where large quantities of straw are available, it is desired to make use of the largest amount that can be used profitably. On the other hand, where there is a scarcity of bedding material, it is oftentimes desirable to care for the animals in such a manner that the least amount of bedding will be required. Throughout this feeding experiment a strict account was kept of the weight of the bedding material. Straw was used exclusively. This was weighed out in large sacks and a record kept of the number of sacks used for each pen. At the close of the experiment, it was found that the same number of pounds was used per animal in each lot. The use of straw was left to the judgment of the feeder. He determined how much was necessary to keep the animals clean and comfortable.

From the foregoing pages it will readily be seen that the differ-

ences in the results of the three methods of confining fattening steers, do not show that one method is markedly superior to another, so far as gain in live weight from the food consumed is concerned. The results of the three methods, as shown by each experiment, are about as uniform as would be expected had the three lots of them been kept under practically uniform conditions. The slight differences in gain are not sufficient to recommend one method over another. While the steers were selected with great care, yet the differences in the individuals of the three lots may account for the slight difference in gain. The fact that a different lot in each experiment made the greatest gain from a given amount of food, tends to show that the variation of the lots is probably due to the individuality of the animals rather than to the difference in the methods of confining and feeding.

It was observed in each experiment that those animals which had a supply of water before them all the time had a somewhat better appetite and consumed their food with greater relish than did those that were turned into the yard to water once each day. Any advantage that one method may show over another is chiefly due to the difference in the amount of labor of attendance.